



Lightning Imaging Sensor (LIS) on the International Space Station (ISS)

Presented by

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ISS Lightning Imaging Sensor (LIS) Overview

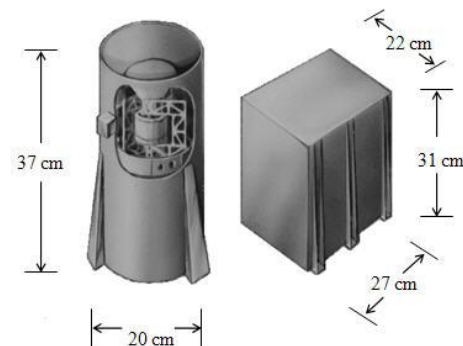


Mission

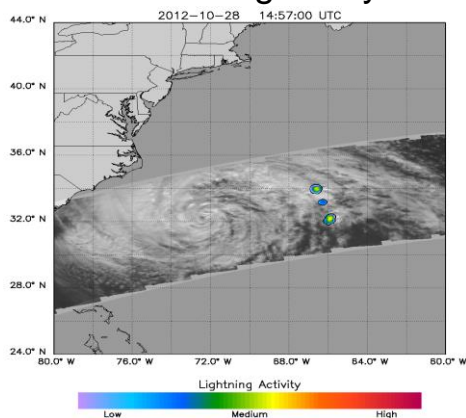
- The LIS instrument used is a space-qualified, flight-spare LIS built for the Tropical Rainfall Measuring Mission (TRMM) and maintained in storage.
- Integrate LIS as hosted payload on DoD Space Test Program STP-H5 mission and launch on SpaceX rocket in November 2016.

Measurement

- NASA, the University of Alabama in Huntsville (UAH) and their partners developed and demonstrated effectiveness and value of space-based lightning observations as a remote sensing tool.
- LIS measures total lightning (*amount, rate, radiant energy*) during both day and night, with storm scale resolution, millisecond timing, and high, uniform detection efficiency.
 - LIS daytime detection is especially unique and scientifically important (~60% occurs during day).
 - Also LIS globally detects TOTAL (*both cloud and ground*) lightning with no land-ocean bias.



LIS Sensor Head and Electronics Unit
(20 kg, 30W, 128 x 128 CCD, 1kB/s)



Need and Benefit

- Lightning is quantitatively coupled to both thunderstorm and related geophysical processes, and therefore provides important science inputs across a wide range of disciplines (e.g., *weather, climate, atmospheric chemistry, lightning physics – including TGF investigations*).
- The LIS on ISS will extend TRMM time series observations, expand latitudinal coverage, provide real time data to operational users, and enable cross-sensor calibration.

LIS Lightning and Background Images
(Super Storm Sandy October 28, 2012)



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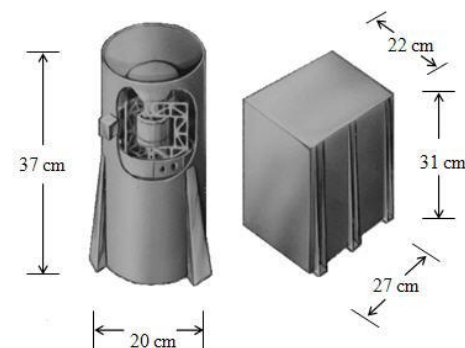


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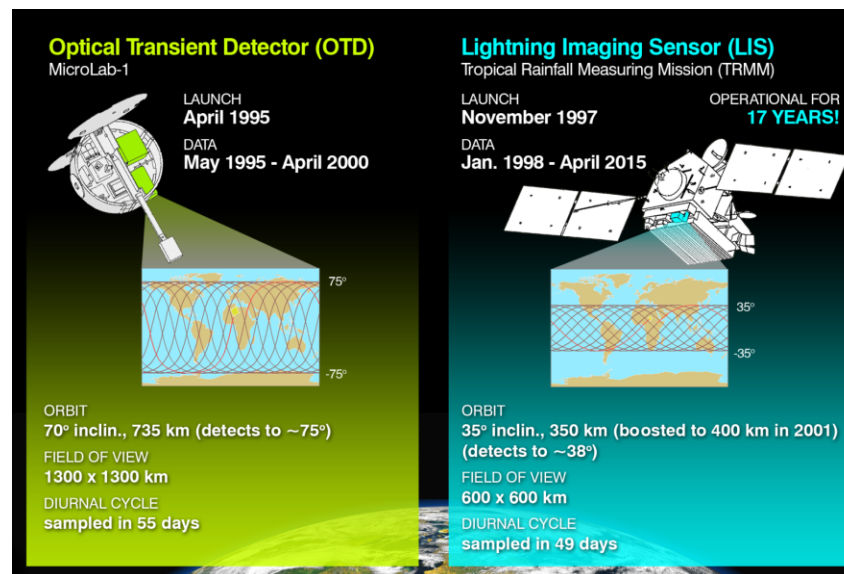


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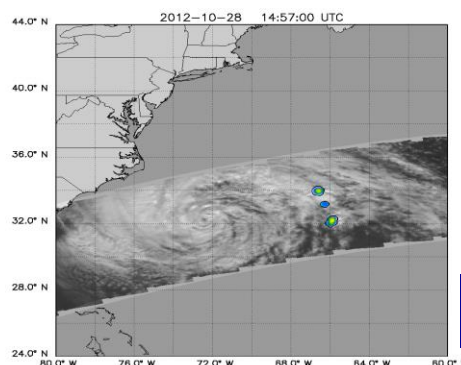


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LIS on ISS builds on a solid foundation of 20 years on-orbit observations of OTD and TRMM LIS.



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Core Science Applications from Lightning

Why Lightning Matters



Weather: Total lightning is strongly coupled in a quantitative way to thunderstorm processes and responds to updraft velocity and cloud particles (concentration, phase, type, and flux).

- LIS acts like a radar in space: it reveals the heart of the cloud.
- Lightning can improve convective precipitation estimates.
- Lightning is strongly coupled to severe weather hazards (winds, floods, tornadoes, hail, wild fires) and can improve forecast models.

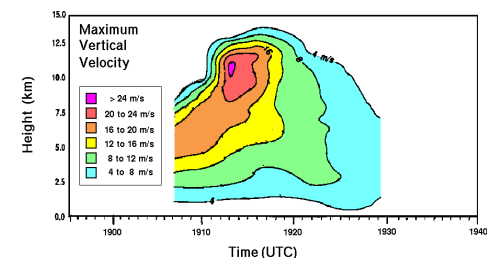
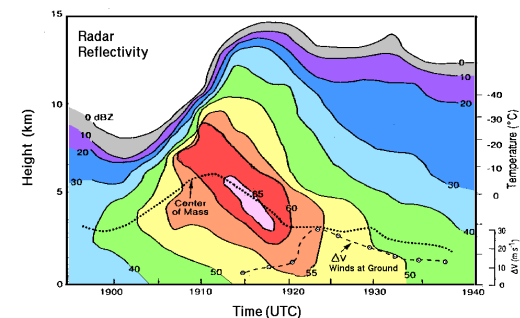
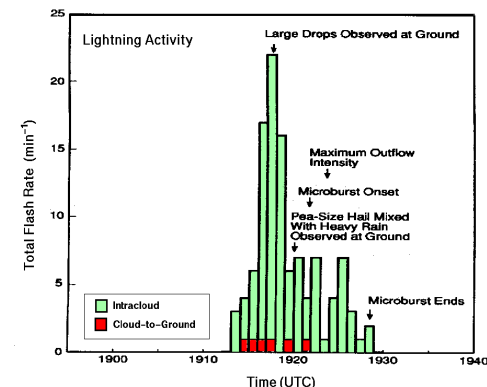
Climate: Lightning is an excellent variable for climate monitoring because it is sensitive to small changes in temperature and atmospheric forcing. ISS LIS will:

- Extend 17 year time series of TRMM LIS, expand to higher latitudes.
- Monitor the occurrence and changes in extreme storms.
- Provide much desired cross-sensor calibrations between platforms.

Chemistry: ISS LIS will help improve estimates of lightning produced NO_x for climate and air quality studies.

- Lightning NO_x also impacts ozone, an important green house gas.
- Climate most sensitive to ozone in upper troposphere, exactly where lightning is the most important source of No_x .

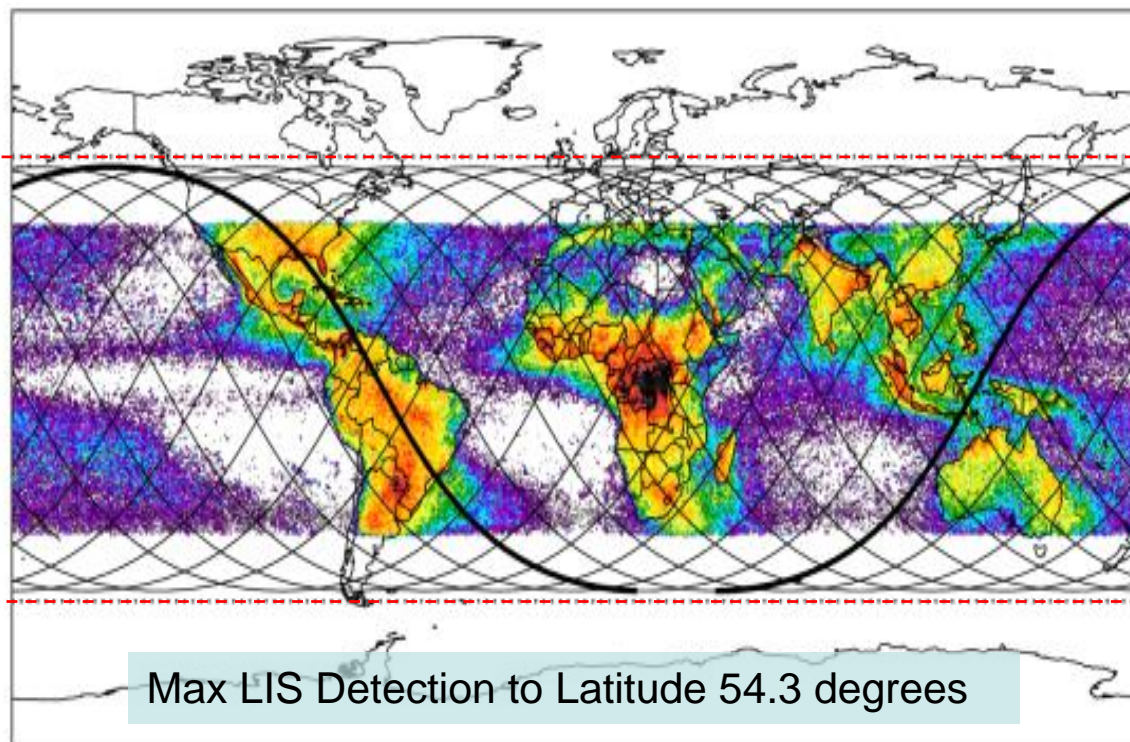
Other: Complementary ISS LIS observations will help unravel the mechanisms leading to terrestrial gamma-ray flashes (TGFs) and Transient Luminous Events (TLEs).



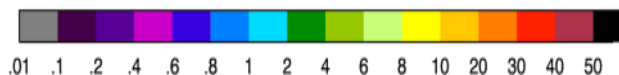
Lightning (top), radar (middle), and vertical velocity (bottom) illustrate strong lightning-storm coupling



Global Coverage of LIS on ISS



Lightning Flash Rate (FL yr⁻¹ km⁻²)

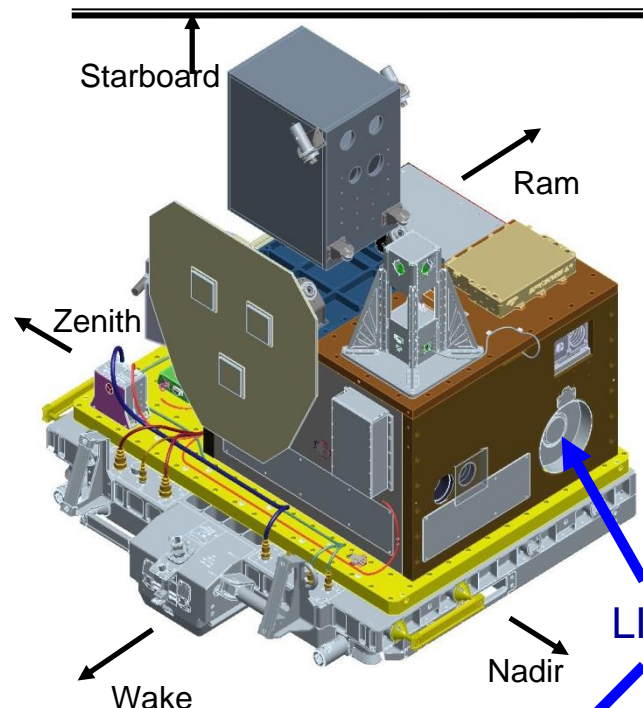


% globe % lightning

- *Global Coverage of LIS/ISS (between red dashed lines) = 81% 98%*
- *Global Coverage of LIS/TRMM (data shown above) = 62% 90%*
- *Expanded Areal Coverage gains important mid-latitude storms, CONUS, and Middle and Southern Europe*



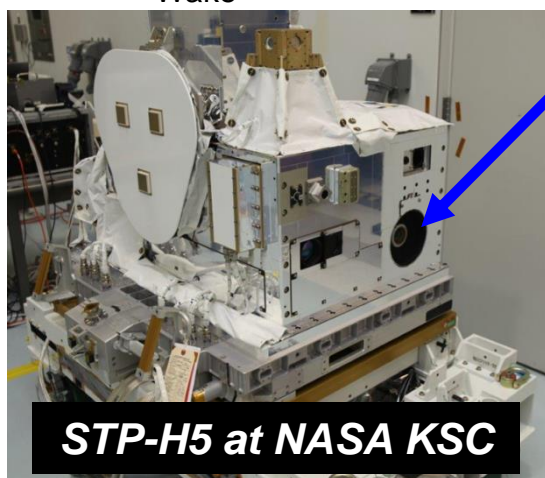
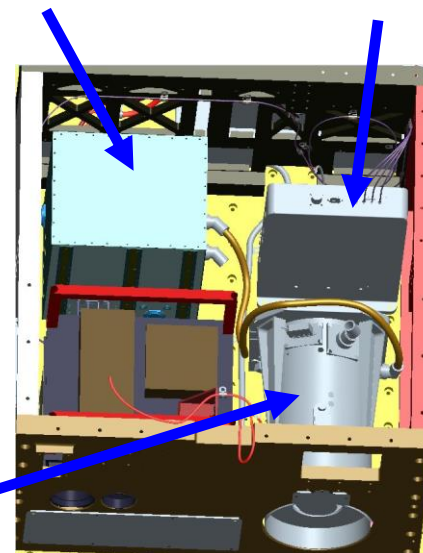
LIS Integration as Hosted Payload on STP-H5



LIS Electronics

LIS Interface Unit

LIS Sensor



STP-H5 at NASA KSC

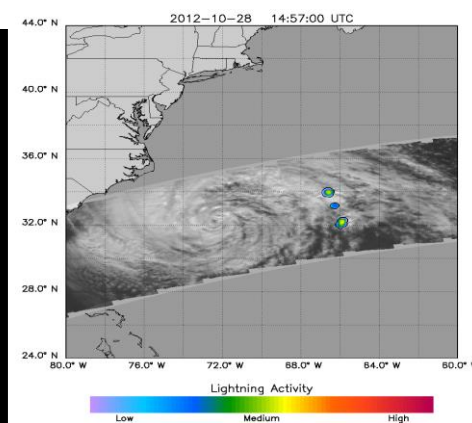
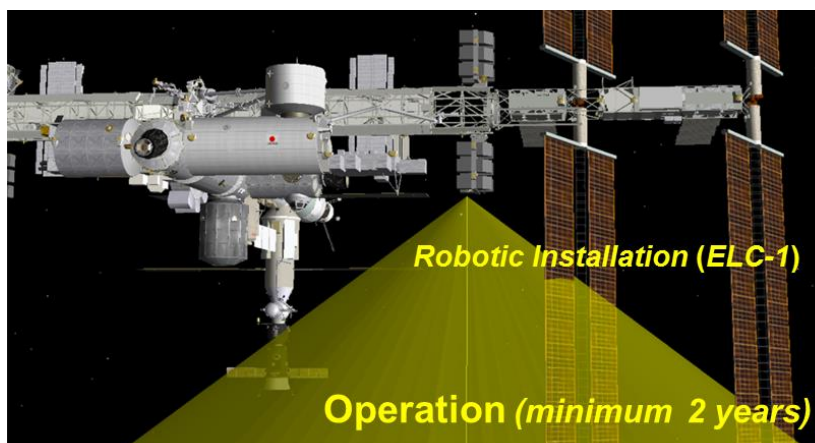
- LIS is one of thirteen instruments on the STP-H5 payload manifest.
- LIS will be installed on ISS in an Earth viewing (nadir) position.
- Payload built on special structure to allow robotic installation on ISS.



LIS Launch, Installation and Operation on ISS

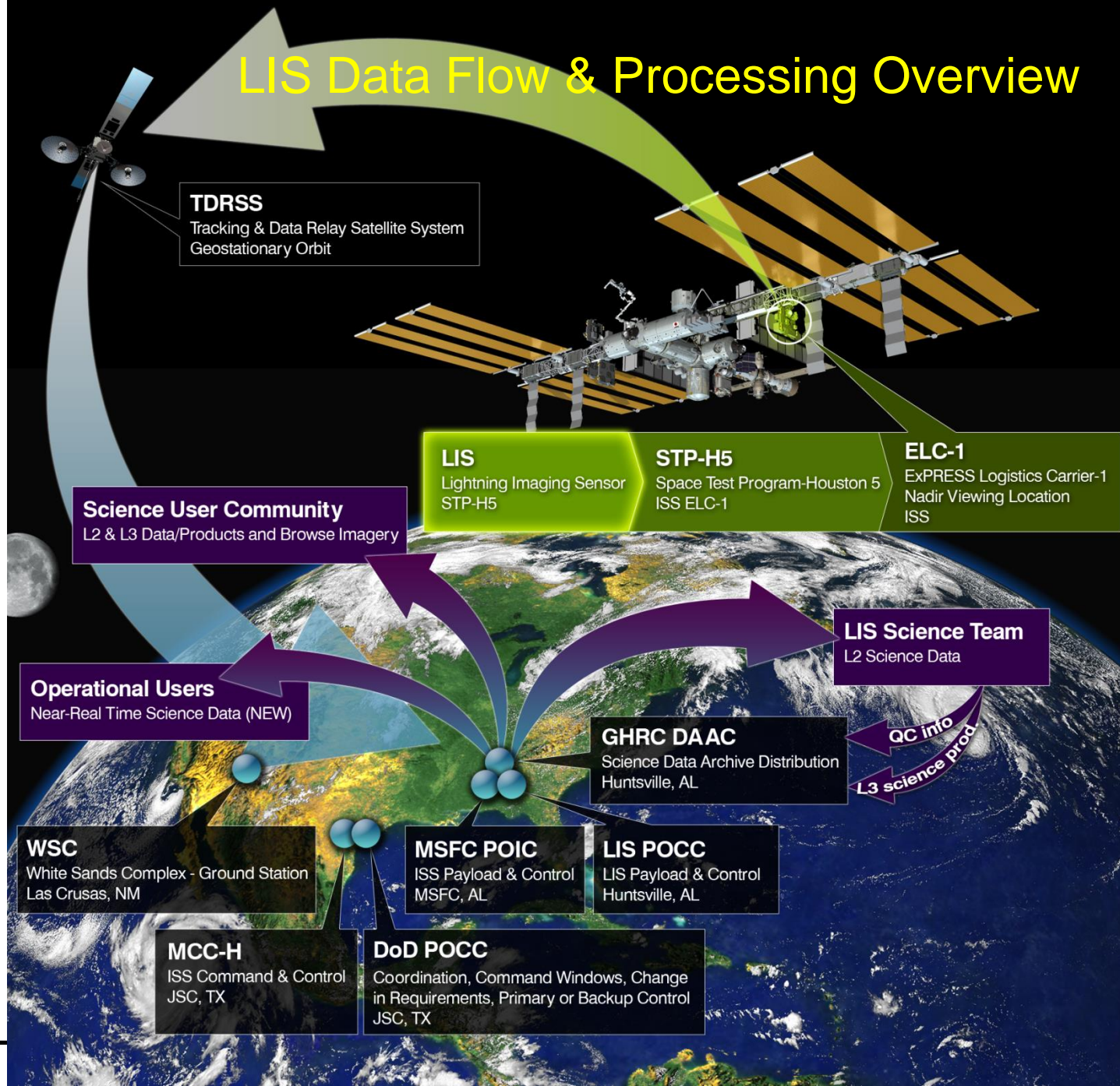


- Shipped to NASA Kennedy Space Center in November 2015 and placed in storage after test.
- Launch to ISS on a Space X rocket with Dragon cargo vehicle in November 2016-TBD.
- Payload will be robotically installed on ISS.
 - Installed on Express Logistics Carrier-1 (ELC-1)
- LIS will be operated for a minimum of 2 years.
 - Mission extension will be sought from NASA





LIS Data Flow & Processing Overview





Mission Operations, Data Handling & Products



- The mission will leverage existing TRMM LIS infrastructure to quickly get ISS LIS data into the hands of users.
 - Key scientists, engineers, and facilities remain in place from recently ended TRMM mission.
 - TRMM LIS mission operations and data handling (processing, archival, and distribution) is robust and easily adapted to the Payload Operations Control Center (POCC) model used by ISS.
 - Hence, LIS data users should see no change from TRMM LIS (i.e., LIS data products and formats, analysis software, documentation and access will remain unchanged)
 - LIS science and data teams have experience delivering real time data to NOAA and other users.
- The LIS instrument and its observations are well characterized.
 - All indications suggest that the flight-spares ISS LIS will perform exactly like TRMM LIS on orbit.
 - LIS observations will be excellent for GLM Cal/Val both because LIS data are well characterized and because GLM's lightning detection approach traces to LIS heritage.
 - LIS data serves as an accepted “benchmark” for global lightning climatology intercomparisons.

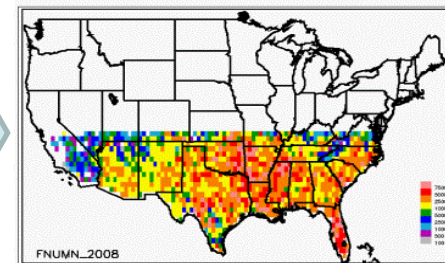


Unique Science Contributions from ISS Platform

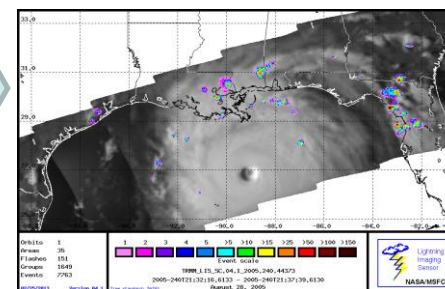
“New and Improved” Science



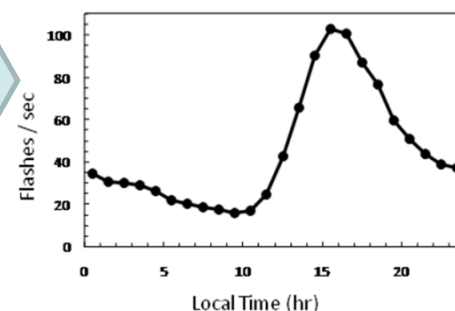
- **Higher latitude lightning coverage missed by TRMM**
 - TRMM LIS misses up to 30% lightning in N. Hemisphere summer
 - Enhance regional and global weather, climate, and chemistry studies
 - Provide CONUS coverage (needed for National Climate Assessment)
- **Real time lightning using ISS for operational applications**
 - Provide real time lightning in data sparse regions, especially oceans (storm warnings, nowcasts, oceanic aviation and international SIGMETs, long-range lightning system validation, hurricane rapid intensification evaluations)
 - Desired by NASA and strongly endorsed by NOAA partners (partners include: NWS Pacific Region, Joint Typhoon Warning Center, Ocean Prediction Center, Aviation Weather Center, and National Hurricane Center)
- **Support cross-sensor calibration and validation activities**
 - Inter-calibrate ISS LIS, GOES-R GLM and MTG LI for improved science and applications (strongly endorsed by NOAA and ESA)
- **Enable simultaneous / complementary observations**
 - Provide critical daytime lightning to better understand mechanisms leading to TGFs and TLEs (strongly endorsed by ESA ASIM and JAXA GLIMS)



TRMM LIS does NOT cover CONUS for climate and chemistry assessments



Real time LIS lightning useful for a host of operations (LIS in Hurricane Katrina)



LIS detects lightning during the day when most lightning occurs



Questions?

